.2.1992-251
University of Alberta Library
0 1620 3415463 1
MAY 21 1992

SCIENCE 14

MODULE 8: TECHNOLOGY AND THE ENVIRONMENT

MODULE 8: TECHNOLOGY AND THE ENVIRONMENT
MODULE 8: TECHNOLOGY AND THE ENVIRONMENT

Distance Learning

Alberta EDUCATION

Digitized by the Internet Archive
in 2017 with funding from
University of Alberta Libraries

https://archive.org/details/science1408albe

Science 14

Module 8

TECHNOLOGY AND THE ENVIRONMENT

Alberta
EDUCATION

Science 14
Student Module
Module 8
Technology and the Environment
Alberta Distance Learning Centre
ISBN No. 0-7741-0469-4

Cover photograph reprinted by permission of Fotostudio PimWesterweel, Naarden, Netherlands.

ALL RIGHTS RESERVED

Copyright ® 1992, the Crown in Right of Alberta, as represented by the Minister of Education, Alberta Education, 11160 Jasper Avenue, Edmonton, Alberta, T5K 0L2.
All rights reserved. Additional copies may be obtained from the Learning Resources Distributing Centre.

No part of this courseware may be reproduced in any form including photocopying (unless otherwise indicated) without the written permission of Alberta Education.

Every effort has been made both to provide proper acknowledgement of the original source and to comply with copyright law. If cases are identified where this has not been done, please notify Alberta Education so appropriate corrective action can be taken.

UNIVERSITY LIBRARY
UNIVERSITY OF ALBERTA

Welcome to Module 8!

We hope you'll enjoy your study of Technology and the Environment.

To make your learning a bit easier, a teacher will help guide you through the material.

So whenever you see this icon,

turn on your audiocassette and listen.

Contents

OVERVIEW 1

Evaluation 2

SECTION 1:

TECHNOLOGY: THE GOOD, THE BAD, AND THE UGLY 3

Activity 1: The Effects of Technology on the Environment 4

Activity 2: The People Crunch 18

Activity 3: Technology Is Not All Bad! 22

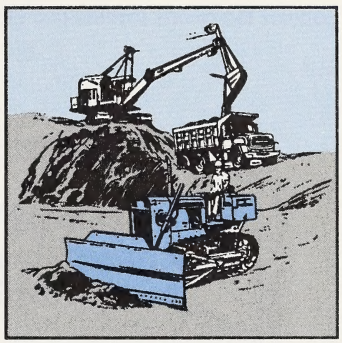
Follow-up Activities 28

Extra Help 28

Enrichment 30

Conclusion 32

Assignment 32



SECTION 2:

SCIENCE AND TECHNOLOGY: THE IMPACT 33

Activity 1: Environmental Pollution 34

Activity 2: Major Solutions 44

Activity 3: What Can You Do? 48

Follow-up Activities 56

Extra Help 56

Enrichment 58

Conclusion 58

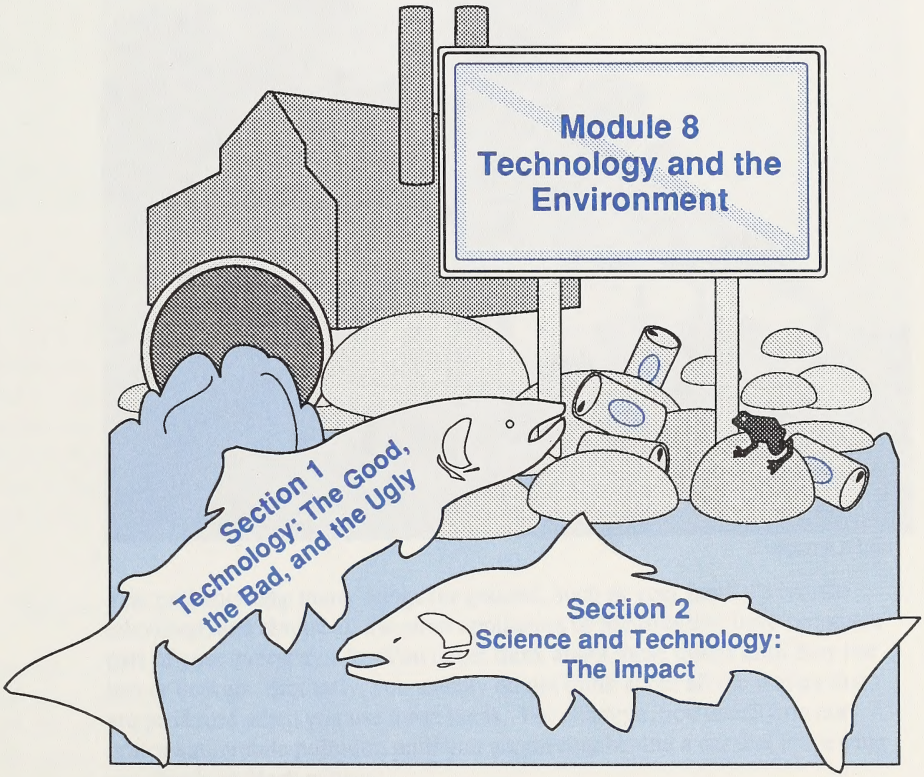
Assignment 58

MODULE SUMMARY 59

APPENDIX 61

OVERVIEW

The industrial revolution set the human race on a course that seemed to lead to a better life for all. Science and technology improved by leaps and bounds, as did the standard of living for those who had access to the new and improved products that were being produced. Today many of the unforeseen consequences of improved science and technology are beginning to affect the planet. More nonbiodegradable products and wastes are being produced, creating more unforeseen consequences to lurk in the future. In this module you will look at the impact that science and technology has had on the environment. You will also learn how society can control and direct science and technology.



Evaluation

Your mark in this module will be determined by your work in the Assignment Booklet. You must complete all assignments. In this module you are expected to complete two section assignments. The assignment breakdown is as follows:

Section 1	=	60 marks
Section 2	=	40 marks
TOTAL	=	100 marks

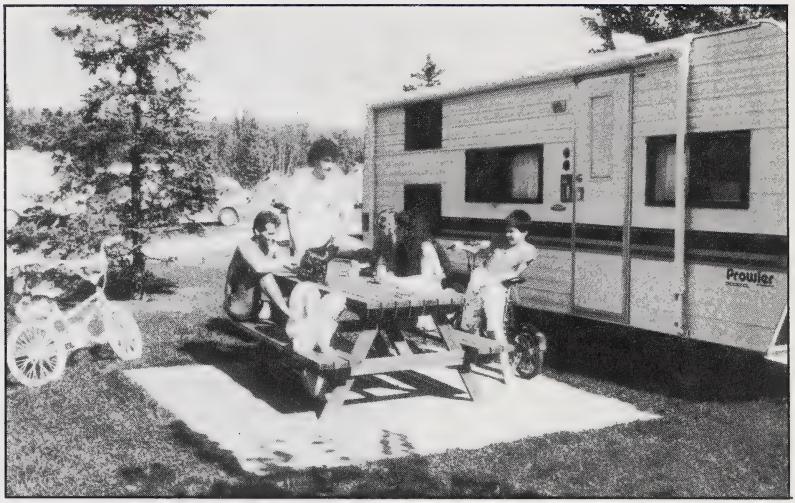
1 Technology: The Good, the Bad, and the Ugly

WESTFILE INC.

You probably take many things for granted, such as your family's car, the television, and almost all the other appliances or luxuries that have become a part of your everyday life. You never think about these things until they are lost or broken. Similarly, you usually do not think about all the wastes that are produced when you use these items. For example, you usually do not notice automobile pollution until you are driving behind a car that is spewing out clouds of black exhaust.

In this section you will study some technological developments and become more aware of their effects on the environment. You will also look at how the environment is affected by the way people use the land. These studies should make you reconsider the effects that your personal activities are having on the environment. What about the activities of everybody else across the country? What effects are they having on the environment?

Activity 1: The Effects of Technology on the Environment



WESTFILE INC.

Have you ever heard the phrase "keeping up with the Jones's"? It seems to be human nature to want all of the things that other people have. Throughout human history people have strived to make their lives safer, more comfortable, and more fulfilling. Science and **technology** have been the tools used to reach these goals. Technology includes everything that is used in the production of a product. You have probably heard of at least one country that would like to produce a certain product but does not have the technology to do so. In this next investigation you will learn to appreciate just how much technology goes into each and every product that is available.

technology - all the inventions and techniques that people have developed to solve practical problems; science at work

Investigation: Is Knowledge Enough?

Imagine that one day you find a door in the strangest place – on a tree in the park. You open the door and step into a strange land. When you turn around, the door is gone. You wander around for a few days and discover that you are alone in this land. There are plenty of fruits to eat, but you really need a knife to cut through their tough skins. Assume that when you came to this land all you had were the clothes on your back. Can you make a steel knife using only your knowledge and the resources around you?

Materials You Need

- your knowledge
- natural resources

Steps to Follow

1. Outline the steps and procedures you would take in order to make a steel knife.

Conclusions

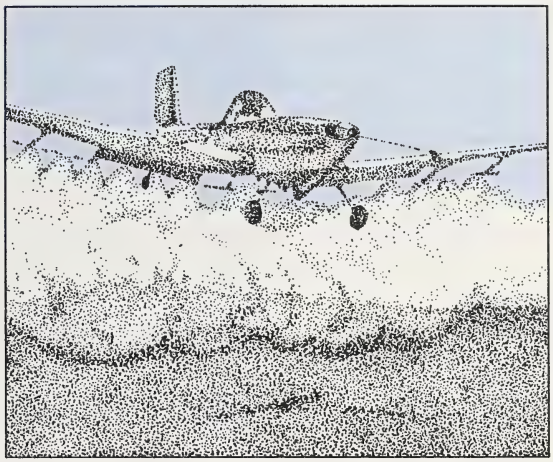
2. List the technologies that you would need in order to produce a steel knife.

3. Explain why some people remained in the Stone Age, even though Europe and some parts of Asia and Africa had moved into the Iron Age.

Iron products have always been very much in demand. At the begininng of the Iron Age people used wood fires and carbon (from coal) to make iron products. What effect did this technology have on the environment? Europe used to be covered in hardwood forests. These forests were systematically cut down to fuel the iron-making industry. Later coal, instead of wood, was used for fuel. The change to coal for fuel continued to produce vast amounts of pollution.

Today iron products are still in demand. The car or bus that you ride in, the cans that your food is packaged in, and many other products found in your home contain parts which are made of iron and steel. Although the damage is often difficult to see, iron production still pollutes the environment.

As a consumer, would you pay more for a product because the manufacturing company spends more money on pollution control? Or would you buy a less expensive product even though the manufacturing company spends less on pollution control? Do you think that other Albertans are willing to buy environmentally friendly products even though they would have to pay more?



4. a. List the products that you think are being produced as a result of the activity shown.

_____

_____

b. List the things that this activity is doing to damage the environment.

_____

_____

_____

_____

_____

c. How could the products of this activity be produced less expensively and with less harm to the environment?

_____

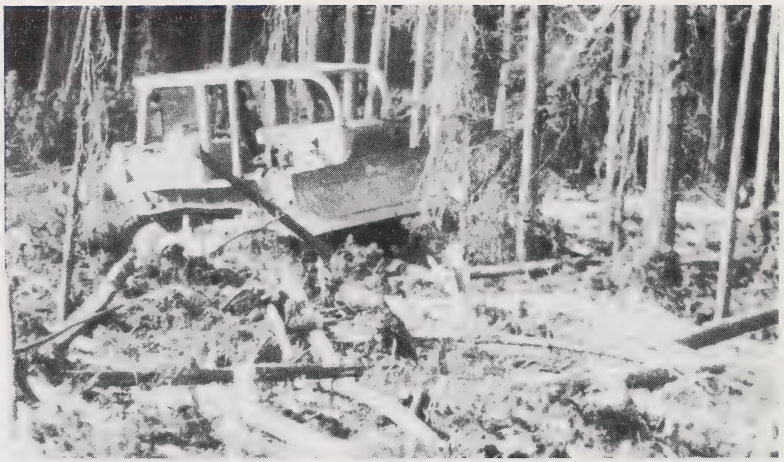
_____

_____

_____

_____

_____



WESTFILE INC.

5. a. List the products that you think are being produced as a result of the activity shown.

_____

_____

b. List the things that this activity is doing to damage the environment.

_____

_____

_____

_____

_____

c. How could these products of this activity be produced less expensively and with less harm to the environment?

_____

_____

_____

_____

_____

_____

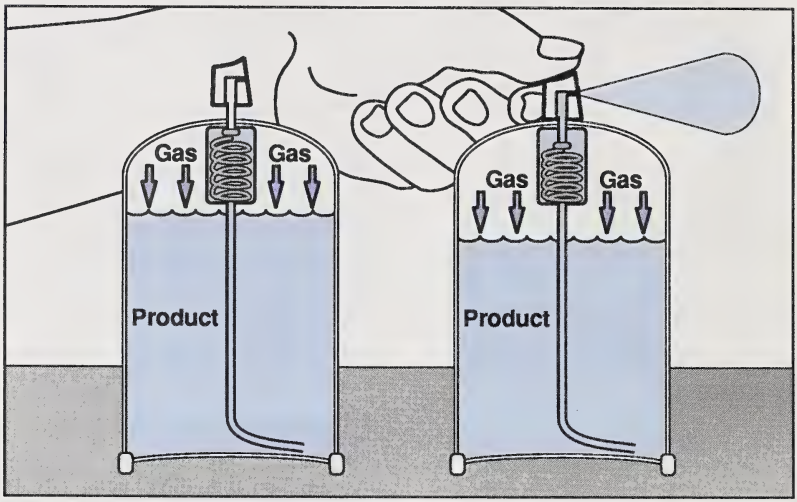
Whenever a product is produced, there is always some waste produced at the same time. Even green plants produce waste when producing food. So where do all these wastes go? Nature has a terrific recycling program that uses almost everything over and over again. Wastes are turned into new products; new products are turned into wastes. Why is there a problem? Look carefully at the technologies that are used to produce the products that you use. Are the wastes produced by these technologies the same as the wastes produced by plants and animals? Unfortunately the answer is no. Human activities that use modern technology often produce **nonbiodegradable** products and wastes. Not too long ago those wastes were simply dumped or burned. Today those old wastes are turning up in the worst places, such as in underground water supplies, in the foods that you eat, and in the air that you breathe. Since nature cannot recycle these nonbiodegradable wastes, it is up to society to use some of its technology to recycle or safely dispose of the wastes.

nonbiodegradable - the inability of a substance to be decomposed by living microorganisms

WESTFILE INC.

How many technologies are there that produce nonbiodegradable wastes or products? How many technologies are there that do not produce any nonbiodegradable wastes or products? Often the technology itself is nonbiodegradable. Look at the following examples to get an idea of the problem.

Sweet-smelling Technology – Air Freshener



What are the technologies involved in making this product and what kinds of wastes are produced? First look at the material in the can. The pleasant smell is probably due to a chemical called an **ester**. Esters are produced from alcohols and organic acids that are derived mostly from the oil industry. While the esters are biodegradable, the production process and machinery involved produce some nonbiodegradable wastes. The **propellant** may be either a **CFC** or a more environmentally friendly chemical (CFCs are nonbiodegradable). Unfortunately, the technologies used to produce environmentally friendly propellants still produce some nonbiodegradable waste. Wait! What about the can? The can is made of metal, probably steel. This means that nonbiodegradable wastes were produced by steel-making technologies as the spray can was manufactured. How about the plastic parts of the can? These were produced by the petrochemical plastic industry. The plastic products and the many wastes from their production are also nonbiodegradable. You could include even more technologies that are required in order to get the spray can to the consumer. Some of these are transportation, wholesaling and retailing, garbage disposal, and energy production.

esters - a group of chemical compounds that possess a pleasant fragrance

propellant - the compressed or liquefied gas that is used to force the contents out of a spray can

CFCs (chlorofluorocarbons) - a group of chemicals which are destroying the ozone layer CFCs are used in refrigerants, propellants, and foam products.

6. Damage to the ozone layer has caused the makers of aerosol sprays to stop using CFCs. Examine various aerosol products in your home or at the store and explain two ways that industry has solved this problem.

_____

_____

_____

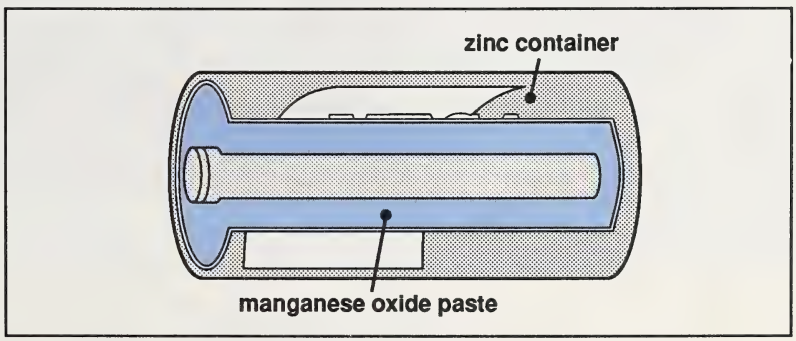
_____

_____

Portable Power

What technologies are involved in making batteries? To answer this question you first need to know what is inside a battery. There are many types of batteries and many different ways of making them. The most common type of battery in your home is the dry cell. Dry cell batteries are used in flashlights, portable radios and stereos, electronic games, and countless other items.

Most dry cell batteries use two kinds of metals. Some examples are zinc/manganese dioxides, zinc/silver oxides, and zinc/mercury oxides. Often the container is made of zinc that is used up as the battery is used. Here is a picture of a very simple disposable battery.



The technologies involved in producing the various metals in a battery produce nonbiodegradable wastes. Once the batteries are used up, they are generally discarded in a landfill site where they also add to the amount of nonbiodegradable waste. The various technologies which supply energy, transportation, and garbage disposal to the overall production process are also involved.

7. Give two environmentally friendly alternatives to using common dry cell batteries in your electronic devices.

_____

_____

_____

_____

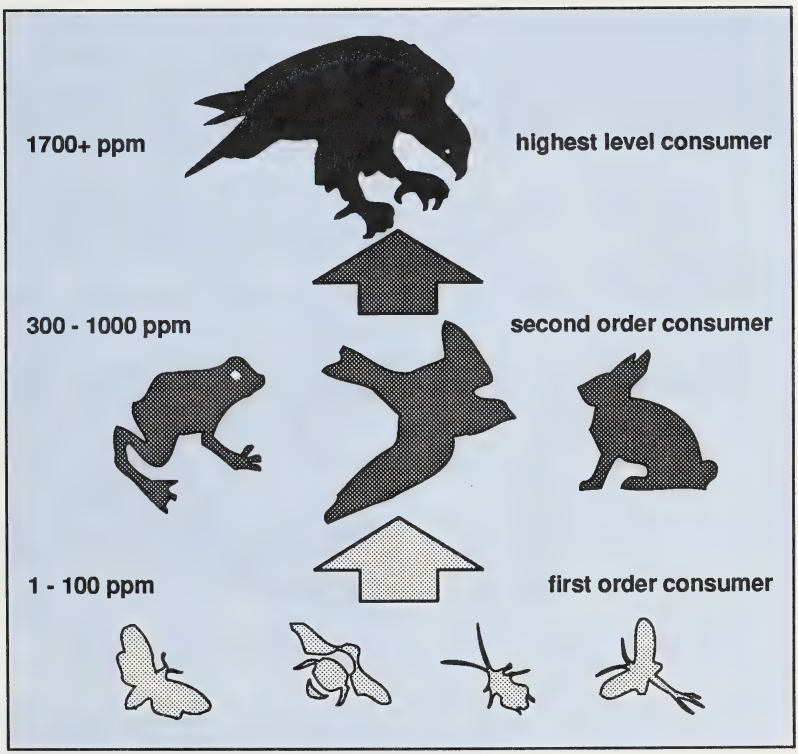
_____

Pesticide Problems

WESTFILE INC.

Science and technology have combined to produce an incredible array of chemicals. A good example is the chemical dichlorodiphenyltrichloroethane better known as DDT. It was first manufactured in 1942 and was found to be an excellent pesticide that seemed to affect only insects. It was used extensively to kill disease-carrying mosquitoes and insects that harmed farmers' crops. DDT was banned from use in the United States in 1973 because it was found that this chemical was fat-soluble and was therefore stored in body fats. DDT is also nonbiodegradable and will exist in the environment for unknown periods of time. The implications of this are serious. Do you remember the rule of ten? Plants take in DDT along with other nutrients from the soil. Insects that eat DDT store it in their body fats.

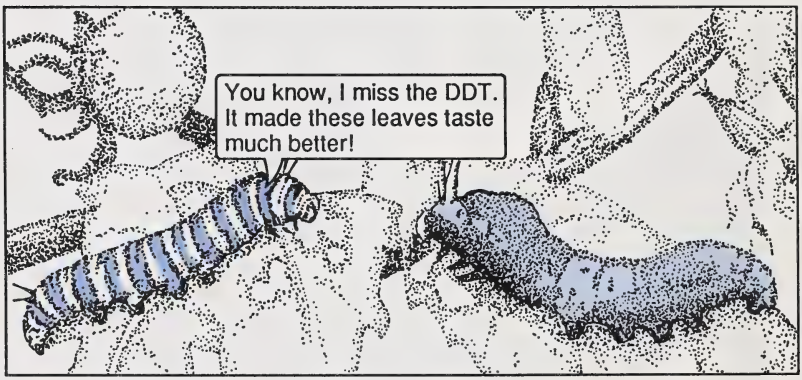
These insects are then eaten by other organisms such as birds, snakes, fish, and other insects. Since a consumer must eat many times its own weight in food, the stored DDT becomes more concentrated as it progresses further up the food pyramid. The highest level consumers have concentrations of DDT in their body fats that can be thousands of times greater than the concentrations of DDT in the bodies of the organisms that first ate it. DDT has an especially harmful effect on bird populations. It affects the thickness of the shells of birds' eggs. The eggshells become very thin and many of the eggs break before the baby birds can hatch. This one factor alone has seriously reduced the populations of hawks, falcons, eagles, and many seabirds.



This is not the end of the DDT problem. Because DDT remains in the environment for very long periods of time, much of the DDT used when it was first manufactured is still around. Estimates vary, but the amount of DDT existing in the environment is believed to be in the order of hundreds of millions of kilograms. DDT is still produced in South America and other places where it has not yet been banned. Even if all DDT production and use was stopped today, it would remain in the environment for many years to come. It might be there for hundreds, thousands, or even millions of years!

8. Pregnant woman in some areas are advised against breast feeding their newborn children because their milk contains high concentrations of DDT. Briefly explain how DDT must have got into the milk?

Wait, there's more! Some insect pests are becoming resistant to pesticides and insecticides. When a pesticide or insecticide is sprayed on a crop or on a pond, most of the insect pests are killed, but some survive. These remaining insects reproduce and pass their resistance on to their offspring. If a pesticide is used repeatedly, the pests may become completely resistant to the poison. Eventually, all the real pests will remain unharmed and possibly only beneficial insects will be killed.



Have you heard of any other similar problems? How about rats becoming resistant to rat poison, disease-causing bacteria becoming resistant to antibiotics, and cockroaches becoming resistant to insecticides?

Technology on Four Wheels

Some people claim that the invention of the automobile was the most important of all inventions. On the other hand, some people claim that automobiles were the worst thing to happen to the planet Earth. Before you make your own judgement, look at the technologies involved in making an automobile.

- metal technologies involved in the production and use of steel, aluminum, chromium, and most other metals
- rubber technologies
- plastics technologies
- electronics technologies
- technologies involving paint, glass, fabric, and many other materials

All this technology just to make a car! Now you have to provide power for the car. This involves the following technologies:

- petrochemical technologies
- battery technologies
- solar power technologies

There are many other technologies involved in providing power to vehicles.

Each technology produces its own products and wastes, most of which are nonbiodegradable. The vehicles also produce vast amounts of pollutants. Canada has banned the use of leaded gasolines in vehicles.

9. Why do you think the ban on leaded gasoline is beneficial to the environment?

_____

_____

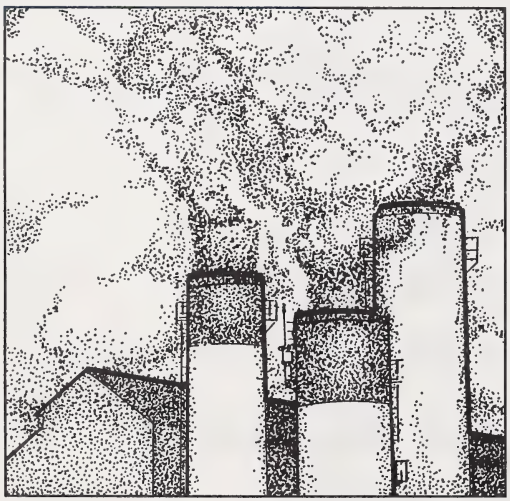
_____

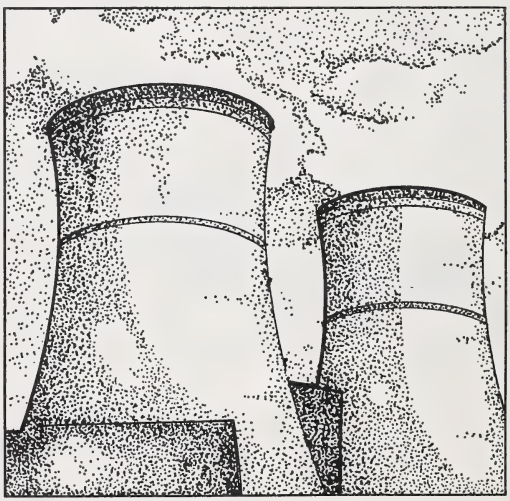
_____

Power on a Large Scale

PCBs (polychlorinated biphenyls) - a group of man-made compounds PCBs are used to get rid of heat in electrical transformers.

Society uses electricity to provide light and power. The technologies used to produce and transport electricity produce nonbiodegradable products and wastes. Do you remember the term *PCB*? PCBs are complex man-made chemicals which were once used as electrical transformer coolants because of their physical properties and ability to last a very long time. They are even very difficult to burn. PCBs are fat-soluble and can be concentrated in living organisms, just like DDT. Therefore, PCBs are considered to be very dangerous to the environment.





Nuclear power plants produce radioactive wastes. Since these wastes are deadly to all living organisms, it is very hazardous to release them into the environment. Although a nuclear power plant appears clean and smoke-free compared to a coal-fired power plant, it is important to note that both nuclear and coal-fired power plants produce wastes.

10. Explain the harmful effects that a product such as a VCR has on the environment. Why is this hard to do?

11. Who is ultimately responsible for recycling nonbiodegradable wastes?

12. How does nature deal with biodegradable wastes?

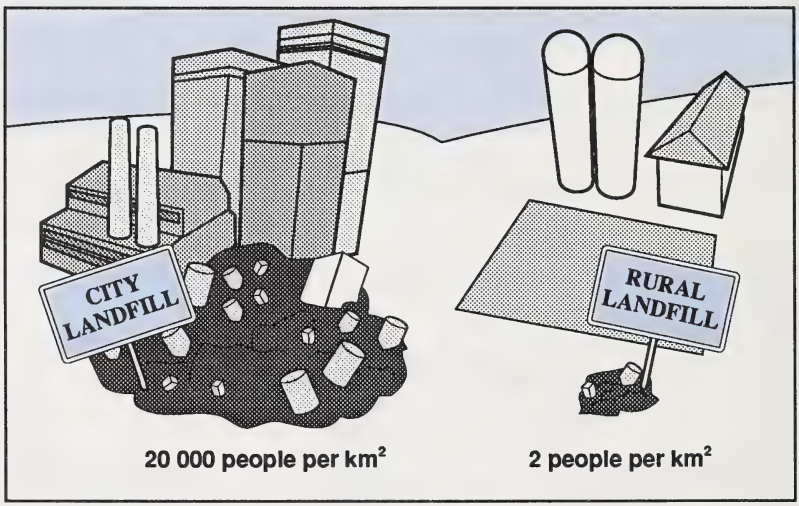
synthetic - man-made; not naturally occuring

13. What are the main problems that society and nature have with **synthetic** chemicals?

Check your answers by turning to the Appendix, Section 1: Activity 1.

Activity 2: The People Crunch

Everybody produces some type of waste. Are you better at recycling and producing less wastes than your friends and neighbours? Hopefully you are. Do you live in a city, a town, or on a farm? What happens to the garbage you produce is affected by where you live. If you live in a city you can probably recycle more garbage than somebody who lives in a rural area. This is mainly because the collection of recyclables is more practical in a city. If this is true, then why are cities having so many problems with garbage disposal? The answer lies in the number of people and industries centralized in a city compared to the number of people and industries spread out over a large rural area.



Assuming that each person produces the same amount of garbage, will a city of 100 km² produce the same amount of waste as a rural area of 100 km²? Of course not! The city will produce many times more personal waste than the rural area. A landfill in the city must be much larger than a landfill in the rural area. Where would you locate a city landfill? In the city or in the rural area? The locating of landfill sites is difficult because of the people living in the surrounding area. Nobody wants a landfill in their backyard.

A city is also home to many large manufacturing industries. Most of these industries produce both biodegradable and nonbiodegradable wastes. The industries produce products for people, regardless of where they live, but the garbage is concentrated in the cities where the factories are located.

1. As the population of an area increases, what happens to the amount of garbage produced in that area?

Each year the average Canadian throws out about 500 kg of garbage. Much of this garbage, such as kitchen scraps, lawn and garden wastes, and spoiled foods, is biodegradable. Why doesn't this garbage just break down naturally and become recycled by nature like it is supposed to? Well, the natural recycling of wastes takes time. A compost heap can only convert so much garden waste into compost over the summer. People, however, produce garbage continuously, sending much of their biodegradable garbage to the landfill. Over a period of years the amount of biodegradable garbage builds up and soon the landfill is full. To compound the problem, biodegradable waste is often mixed with nonbiodegradable waste. Some of the wastes become polluted with toxic chemicals, making nature's job even more difficult. Thus, the landfill becomes filled with biodegradable, nonbiodegradable, and sometimes even hazardous materials. Regardless of what lies below, the whole landfill site is eventually covered with soil and used as a park, golf course, or even as farmland.

Why are good locations for city landfill sites so hard to find? There are a number of reasons.

- The landfill site must not pollute any water supply, whether it is a lake, river, or groundwater. Landfill sites are notorious for having pollutants seep into the groundwater. The polluted groundwater is often carried many kilometres away from the landfill site.

- A landfill site is usually dirty, smelly, and unsightly. There are very few people who would want to live downwind from a landfill, let alone have one next door.

- Landfill sites take up large areas of land which could probably be used for something else.

With all of these restrictions it is not hard to see why a good location for a landfill can be hard to find. Many cities in North America are now running out of landfill space. Some cities are trucking their garbage great distances, while others are dumping their garbage in the ocean or are trying to burn it.

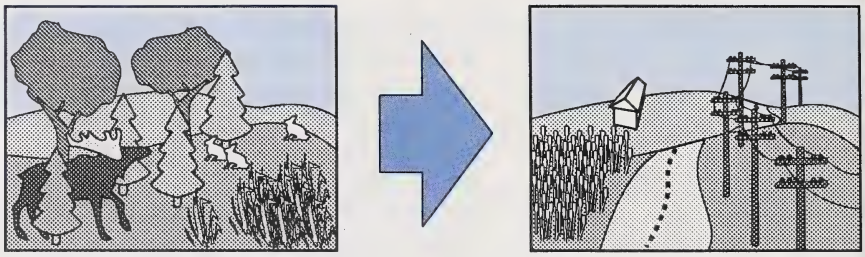
2. Can you think of any ways to solve the problem of garbage disposal?

_____

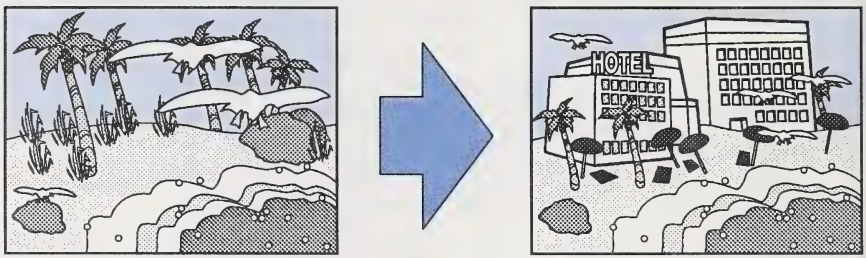
_____

_____

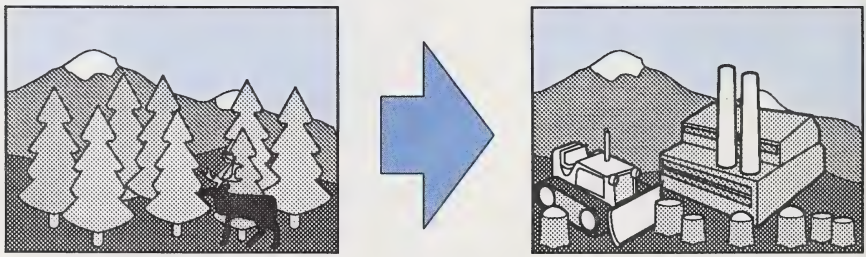
_____



land before land after



seacoast before seacoast after



forest before forest after

Landfills are only one way in which land is used and changed because of the use. Farming usually replaces forests, grasslands, or wetlands with uniform land surfaces covered with crops. These farming practices have major impacts on the environment. The land becomes prone to erosion and contamination because of lack of protection and the use of chemicals.

Society needs wood products such as lumber and paper. Forests are being cut down to fulfill society's needs. Deforestation also leads to erosion and the destruction of the homes of many animals.

Society needs wide, paved roads so that travel is faster and safer. Power lines and pipelines also require wide zones of cleared land so that trees do not interfere with the operation and repair of the lines.

Society needs warm vacation spots. Hotels and resorts are often built in very delicate areas in order to meet this need. Native plant and animal species are displaced, often permanently, when the land is changed.

Virtually every human activity affects the land and causes major changes in the environment.

3. a. List at least four human activities that cause major changes in land use.

_____

_____

_____

_____

b. For each of the ways listed, explain what kinds of changes occur in the environment.

_____

_____

_____

_____

_____

_____

4. How would you change present land use practices in order to preserve the natural environment?

_____

_____

_____

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 2.

Activity 3: Technology Is Not All Bad!

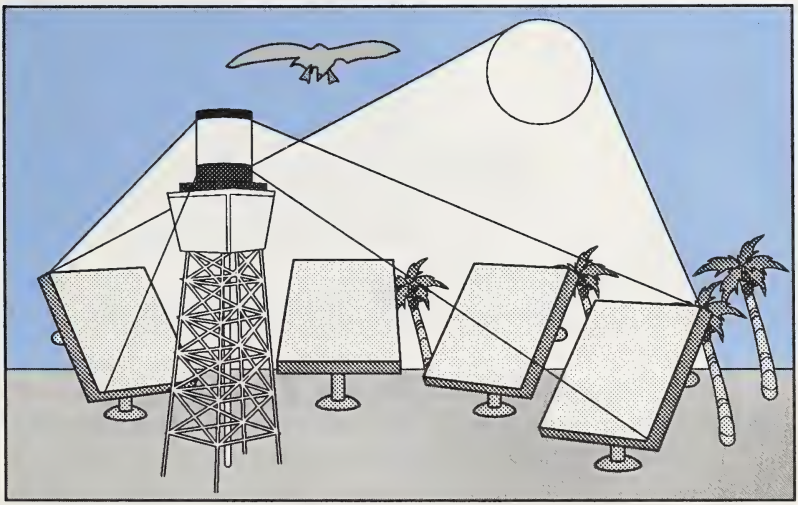
WESTFILE INC.

Are most human activities bad for the environment? Are science and technology responsible for increasing human impact on the environment? It seems that the answer to both questions is yes. Science and technology are used by people to produce things that they want, usually at a high cost to the environment. Through a curious twist, science and technology are also very important in getting people out of this situation. Science and technology may enable humans to get the products they want at a price they are willing to pay and with minimal damage to the environment. It is up to the people to make this change occur before more serious environmental damage occurs.

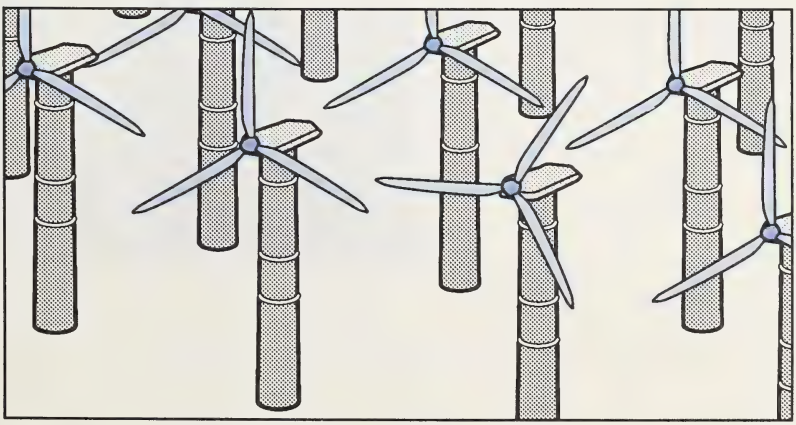
One of the biggest threats to the environment is pollution from energy production. Most of the things you do require some sort of fuel or energy. Fuel that is burned in automobiles produces vast amounts of polluting gases. Both science and technology contributed to the production of the automobile and the fuel (gasoline). Science and technology are now being put to work to produce more fuel-efficient automobiles and to reduce the amount of pollutants that automobiles produce. Unleaded fuels and catalytic converters are two examples of the progress being made in this area. Electrical energy production requires massive hydroelectric projects or large coal-fired plants. Both of these technologies produce enormous environmental changes. Solar, wind, geothermal, and nuclear energy are being further developed and may soon be major sources of energy. It is up to society to work towards the development of energy sources that are less damaging to the environment.

Alternate Energy Sources

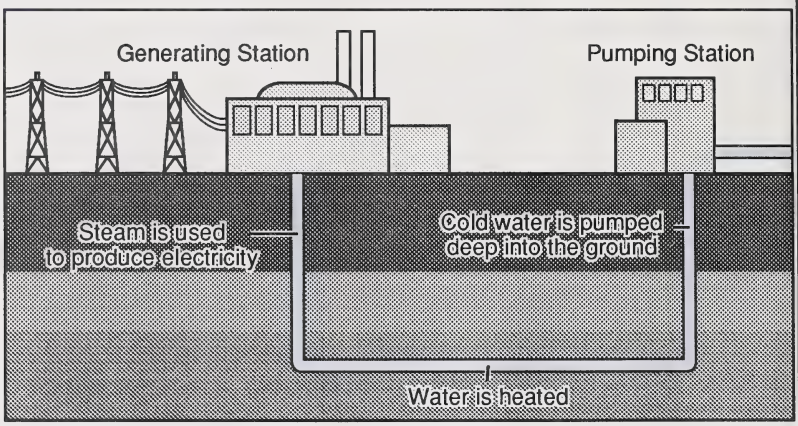
Do you have a solar-powered calculator? These calculators do not require batteries or outside electricity. All of the power is supplied by a solar cell which converts light into electricity. Solar cells are also used to power almost all of the artificial satellites which have been sent into space. Even more of the sun's energy can be converted into useful electrical energy by a solar furnance. A solar furnance uses mirrors to focus the sun's rays on a metal target. Water pumped into the target turns to steam and is then used to turn turbines which generate electricity.



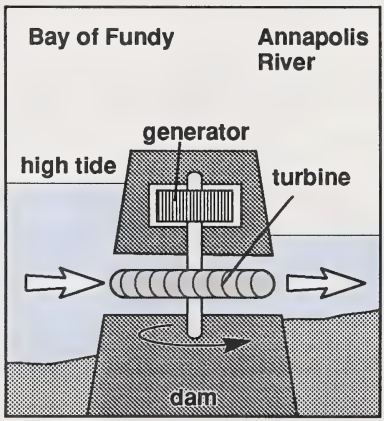
Have you ever seen a windmill farm? Areas that have steady winds are perfect locations for these. The windmills convert wind energy into electricity without producing pollution.

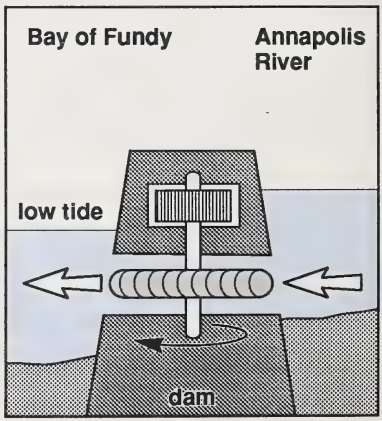


Geothermal generating stations use the heat energy from deep in the earth to produce steam from water. The steam is then used to turn turbines that produce electricity. Since water is used to provide the medium for energy transfer, there is no pollution.

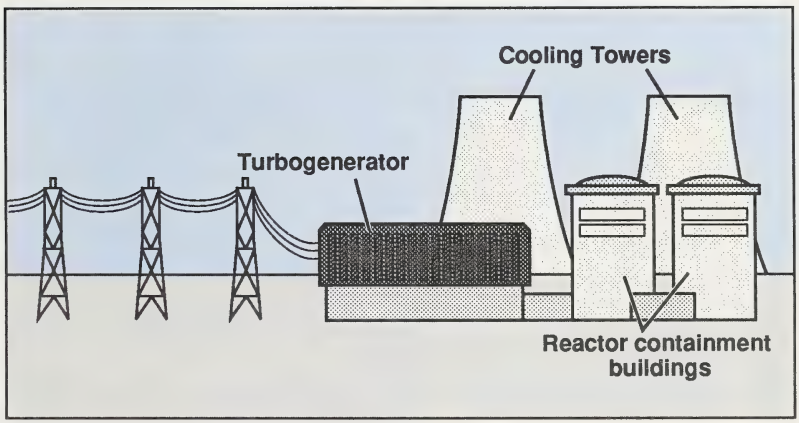

Generating Station
Pumping Station
Steam is used to produce electricity
Cold water is pumped deep into the ground
Water is heated

Tidal hydroelectric stations are able to use the constant ebb and flare of the tides to produce electrical energy. Dams are built on strategic locations, such as on the Bay of Fundy in Canada, to extract energy from the ocean tides. The turbines within the dam are reversible – able to turn one direction as the tide rises and another as the water level falls. This is a pollution-free way of producing electricity.





A nuclear power plant is not pollution free. Large amounts of water are used to cool the radioactive core and the plant produces radioactive wastes. There is an argument to be made in favour of nuclear power plants, though. If the radioactive wastes can be recycled or safely disposed of, the nuclear power plant will not pollute the atmosphere. However, accidents have happened and there is a worldwide effort being made to reduce the number of nuclear power plants.



There are many other areas where science and technology have combined to reduce pollution while still producing the products that people require. One of these areas is the oil industry. Deep sea drilling, ocean shipping, constructing pipelines, and refining all require high technology to safely produce petroleum products. You have probably heard of major oil spills, petrochemical plant disasters, and groundwater pollution from leaking storage tanks. Most of these problems can be solved by improving the technologies that are involved.

1. a. What are some of the advantages of using solar heat in your home compared to natural gas or electricity?

_____

_____

b. What are some of the disadvantages?

_____

_____

2. Why are the alternative forms of energy, such as those that use solar, wind, and geothermal sources, not used extensively?

_____

_____

_____

_____

_____

When people talk about the quality of the environment, they often speak in terms of human needs and wants. For example, if science and technology could get rid of mosquitoes, would the quality of the environment improve? Some aspects of the environment may be improved, but overall the changes may be for the worse. Fish populations in your favourite lake may decrease because one source of food; the mosquito larvae, has disappeared. You have to be careful when viewing the environment simply from a human point of view.

Science and technology are developing simpler birth control methods. What effect would the use of simpler birth control measures in third world countries have on the environment? With less people demanding food, shelter, water, and various products, the environment would improve. If the population is kept at a level that the environment can support at any time, people will be able to survive without causing further damage to the environment. When people are starving they will eat everything that is edible. This can cause great problems for the environment. Virtually all animals and vegetation can be destroyed, leaving no future food sources. Do you know of any place on Earth that is currently experiencing environmental problems because of human overpopulation?

Technology is also important in food production. Technologies such as tractors, cultivating equipment, harvesting equipment, chemicals, irrigation systems, and research in areas such as new seed development are very important in increasing food production. Using less land to produce the required amount of food will lessen the impact of agriculture on the environment. Forests, grasslands, and wetlands will not have to be destroyed in order to obtain new farmland.

3. a. What are some advantages of simpler birth control methods in third world countries?

_____

_____

_____

_____

b. Do you think the same birth control measures would be beneficial to Canada? Explain your answer.

_____

_____

_____

_____

_____

4. What kinds of technologies could be used in third world countries to increase food production?

_____

_____

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 3.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Technology is the sum of all inventions and methods used to solve a problem. The web of technologies required to make even a simple product is very complex. Technology produces both products and wastes, many of which are nonbiodegradable. Also, it often allows humans to exploit and damage the environment.

Science and technology have many effects on the environment: many different chemicals which often cause terrible problems for living organisms are produced; densely populated areas produce far more wastes than the environment can recycle; large populations place demands on the environment to supply raw materials, energy, food, and water; and human activities often result in major changes to the environment. Science and technology can also be used to improve the quality of the environment. Cleaner fuels, more efficient pollution controls, and more efficient engines all contribute to a cleaner atmosphere. Hazardous waste disposal sites, recycling plants, and less damaging chemicals are all ways in which science and technology are cleaning up the environment.

1. Why does the production of any product also involve the production of wastes?

2. What eventually happens to the nonbiodegradable wastes that are produced by technology?

3. Many parts of Canada now use natural gas for heating homes. Burning natural gas produces waste products consisting mainly of carbon dioxide and water. Why is there still an environmental problem with the burning of natural gas as a fuel?

4. Synthetic chemicals are often nonbiodegradable. In terms of the food chain, what happens to a nonbiodegradable chemical that is soluble in fats?

5. Why is recycling a more important issue today than it was in the past?

6. The governments of some countries have considered adopting a policy which allows only one child per married couple. Discuss one unforeseen consequence of this policy and its effects on the environment.

_____

_____

_____

_____

_____

Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

Simple Ideas Can Benefit Both Society and the Environment

Environmentalist, Clayton Askew, released about 15 of his turkeys from their pen (next to the garage) for about four to five hours each day during the grasshopper hatching season. Unlike chickens, turkeys do not scratch the ground and Clayton found that the garden plants that the turkeys stepped on were not damaged. The grasshoppers were totally controlled. He suggested that most farmers have some kind of building that can be used to keep turkeys once winter conditions have passed. Obtaining feed for the turkeys is also inexpensive since most farmers have cracked grain and weed seeds leftover from cleaning their grain.

Clayton contacted food banks in his area and found that they would be delighted to have any extra turkeys. He believes that if the farmers in areas where grasshoppers are a problem used "natural pest control" and each donated two or three turkeys to the food banks in their areas, users of those food banks could enjoy a turkey a month for a year!

1. What are the benefits of Clayton Askew's approach to controlling grasshoppers by using turkeys instead of insecticides?

2. If this system is so good, why is it not used everywhere?

3. Describe how society's needs and wants play a vital role in changing technology so that its products and wastes are less harmful to the environment.

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion

Society is ultimately responsible for ensuring that science and technology are used in ways that will cause the least harm to the environment. As an individual you must demand that environmentally friendly technology be developed to replace the current polluting technologies. Since people must use technology, people must also ensure that this technology does not destroy the environment in which they live. The future of all life on Earth depends upon the actions that are taken now.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 1.

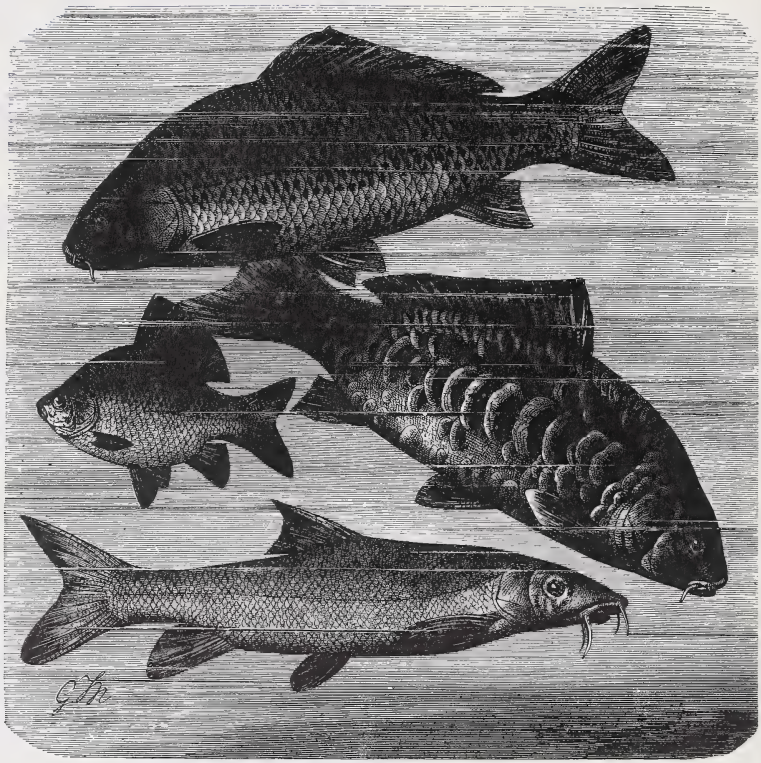
2 Science and Technology: The Impact

PHOTO SEARCH LTD.

All actions have consequences. If you touch a hot stove with your hand, chances are that you will get burned. If you drive too fast you may get into an accident, be fined for speeding, or even lose your driver's licence. Most of your actions have immediate consequences; you quickly learn to avoid those actions that have unpleasant consequences. Many actions have unforeseen consequences because there is a long delay between the action and the consequence. For example, people who start to smoke are unlikely to get lung cancer or emphysema right away, but in later years they may get these or other diseases as a consequence of their smoking.

Many human activities, especially those involving technology and science, can have major unforeseen consequences that don't take place until far into the future. Once the damage is done it can be very hard, if not impossible, to repair. In this section you will study some actions which resulted in serious unforeseen consequences. You will also look at the society's role in the use of science and technology.

Activity 1: Environmental Pollution



In the early 1950s a strange illness began to strike people who lived in villages near the city of Minamata, Japan. Doctors incorrectly diagnosed the illness as brain tumors, syphilis, cerebral palsy, and many other ailments. Children were being born blind and retarded. Children and adults who had been healthy suddenly became crippled and unable to even feed themselves. By the time that experts were called in to help, over fifty people were seriously ill – many of them were dying.

Careful study showed that most of those being afflicted belonged to the families of fishermen. Fish from the area were caught and fed to laboratory animals, who soon began to show the same symptoms as the sick people. So the fish were causing people to become ill; but why? After months of study and research it was noted that the fish had high levels of mercury as did the people who were eating them. The source of the mercury was finally traced back to a large chemical factory, located in the city of Minamata. The factory was dumping its wastes into Minamata Bay and the mercury was becoming concentrated by natural food chains in organisms such as fish. Because people were being poisoned in such a horrible way, the company responsible for the pollution was quickly forced to clean up its wastes.

methylmercury - a toxic mercury compound which tends to accumulate in living organisms

At about the same time, it was noted that bird populations in Sweden were decreasing at an alarming rate. A naturalist noticed that many birds were dying while eating seeds from fields soon after the farmers had planted their grain. What do you think was killing the birds? Farmers were treating their seeds with **methylmercury** to reduce plant disease and increase crop yields. The birds eating the mercury-treated seeds were in turn being eaten by hawks and falcons. Most types of birds were dying. Even though the source of the poisoning was found, the farmers were not forced to stop using treated seeds. Why not? Since people were not being affected, the use of the seeds continued. High crop yields and less plant disease were more important than birds.

Farmers in Sweden do not use mercury treated seeds today, but it was not the dying birds that made them stop. Some farmers were feeding mercury-treated seeds to their farm animals. The eggs and meat of these animals were found to contain high levels of mercury. The government finally banned the use of mercury in agriculture because it was feared that people could be poisoned.

1. What were the unforeseen consequences of dumping chemical wastes that contained mercury compounds into rivers or oceans?

2. What were the unforeseen consequences of using seeds treated with methylmercury?

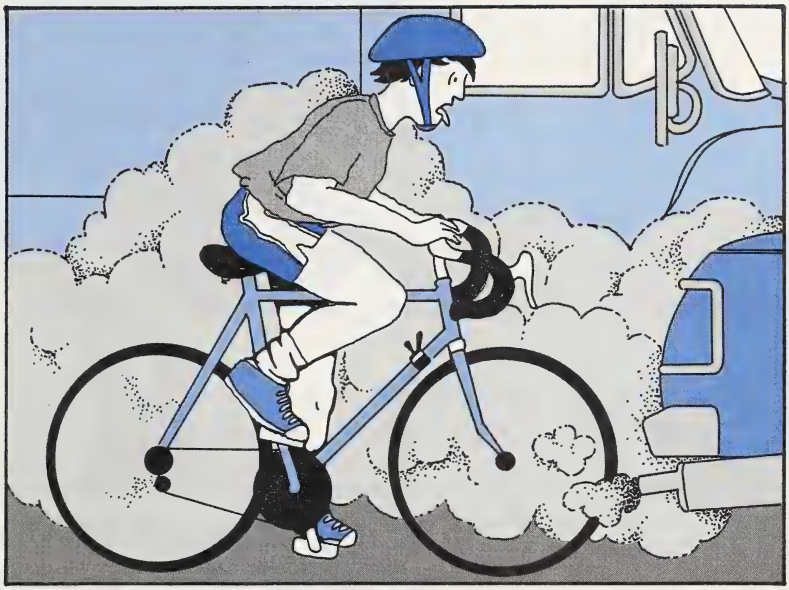
3. How long do you think a mercury pollution problem would last?

4. Have you heard of any cases of mercury pollution involving fish contaminated with mercury in Canada?

Air Pollution

Have you ever gone to the local bingo hall? You enter feeling lucky and keen with the anticipation of winning. You notice that the majority of bingo players are smoking but say to yourself, "No big deal, a little cigarette smoke never hurt anyone." As the night wears on, your eyes and throat start to burn and you seem to have developed a headache. What you have just experienced is air pollution; not very pleasant is it?

The smokers at the bingo hall are not the only sources of air pollution. Each day hundreds of jet planes, thousands of factories, and millions of automobiles and households are sending wastes into the air you breathe. In densely populated areas these wastes build up to form an unhealthy haze or smog – the immediate consequences of air pollution.

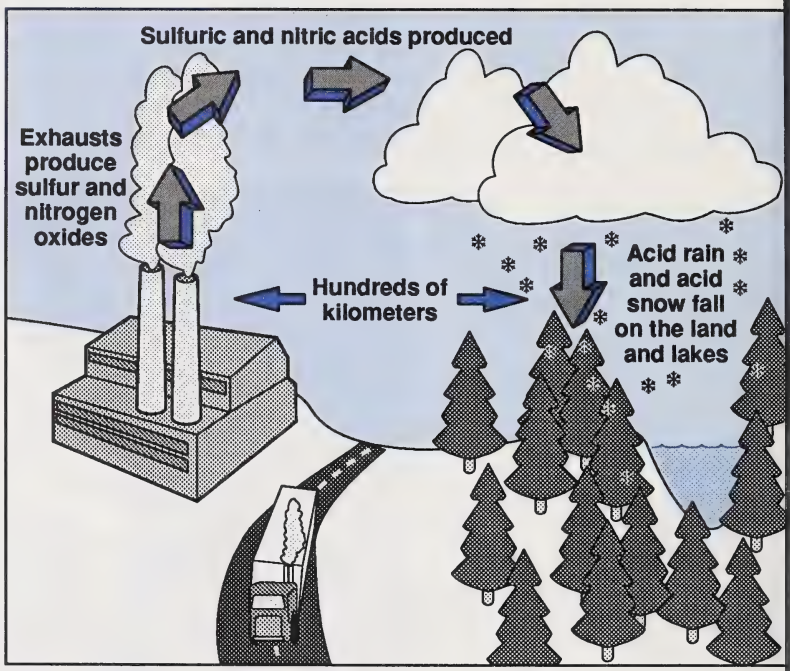


There are two other consequences of air pollution that scientists are quite knowledgeable about; acid rain and the greenhouse effect. You should also be aware that there may be many more consequences of air pollution that are still unforeseen.

Acid Rain

Whenever fossil fuels are burned, sulfur and nitrogen oxides are produced. Air currents carry these gases high into the atmosphere where the sulfur and nitrogen oxides react with water vapour to produce sulfuric and nitric acids. These acids then fall to the Earth as acid rain or acid snow. They usually fall far from the source which produced them, often in other countries. **Acid precipitation** damages or kills forests, lakes, and soil. It is only one serious unforeseen consequence of burning fossil fuels for the production of power for transportation, industry, and private use.

acid precipitation - acidified water that falls to the Earth as rain, snow, or any other form


Sulfuric and nitric acids produced
Exhausts produce sulfur and nitrogen oxides
Hundreds of kilometers
Acid rain and acid snow fall on the land and lakes

The eastern provinces of Canada are experiencing severe problems in their lakes and forests due to acid precipitation. Over 50 percent of this acid precipitation comes from the highly industrialized northeastern United States

5. What is acid precipitation?

_____

_____

_____

6. Why is acid precipitation often called acid rain?

_____

_____

7. What is an unforeseen consequence of the highly industrialized areas of the world?

_____

_____

_____

_____

The Greenhouse Effect

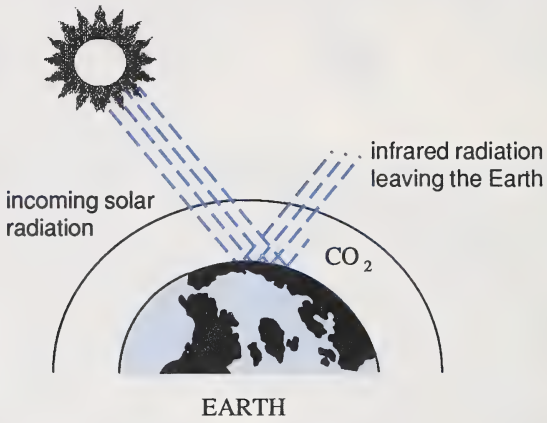
What is a greenhouse? It is an enclosed area that lets sunlight shine through plastic or glass walls. A large amount of sunlight is absorbed by the plants and materials inside the greenhouse and is converted to heat. As a consequence, the air inside the greenhouse becomes much warmer than the outside air.

greenhouse effect - the warming of the Earth's surface and atmosphere because of increased levels of gases such as carbon dioxide and methane

The **greenhouse effect** refers to a similar process that is occurring all over the Earth. Something is either letting in more sunlight or preventing heat from escaping from the atmosphere. Since there is nothing that human technology can do to increase the amount of sunlight entering the atmosphere, there must be something being added to the atmosphere that traps heat. Experiments have shown that many gases can trap heat. Carbon dioxide and methane are two of the worst offenders.

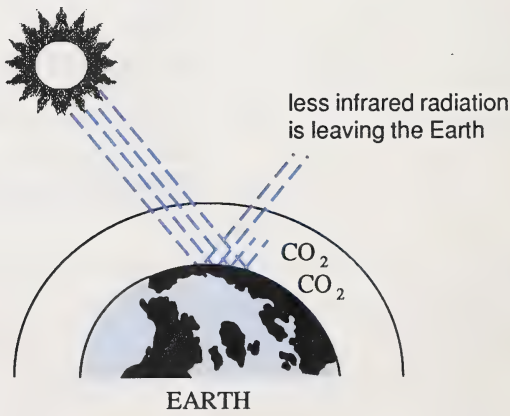
Water vapour and carbon dioxide make up the majority of the gases produced when wood and fossil fuels are burned. Each year almost 5 billion tonnes of fossil fuels are burned producing as much as 20 billion tonnes of carbon dioxide. The amount of carbon dioxide in the atmosphere has increased by about 30 percent in the last 100 years. It is projected that the present carbon dioxide levels will increase by 200 percent in the next 100 years. Methane emissions from increased cattle populations are also increasing, but these amounts are almost insignificant when compared to carbon dioxide emissions.

How does the greenhouse effect work? Look at the following diagram.

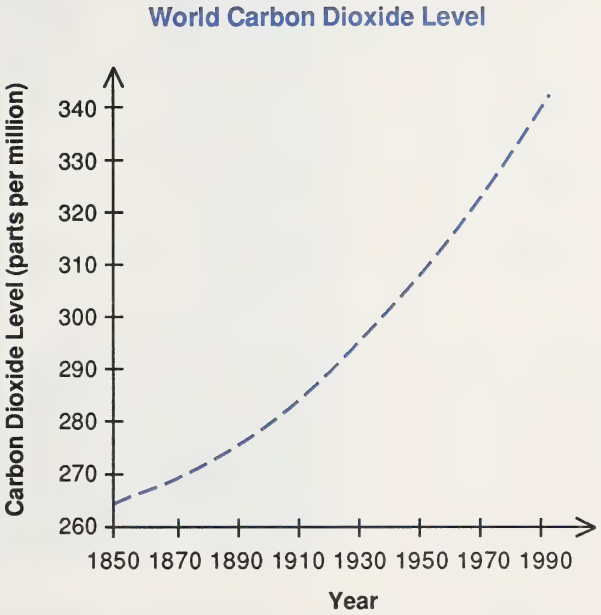


Incoming solar radiation has a short wavelength and, therefore, is not absorbed by carbon dioxide or any of the other greenhouse gases. The incoming solar radiation is absorbed by the Earth and reradiated at longer infrared wavelengths. Carbon dioxide and the other greenhouse gases absorb some of this infrared radiation trapping the heat in the atmosphere. The amount of heat trapped in this way helps determine the average temperature of the Earth.

What happens when more carbon dioxide and other greenhouse gases are released into the atmosphere?

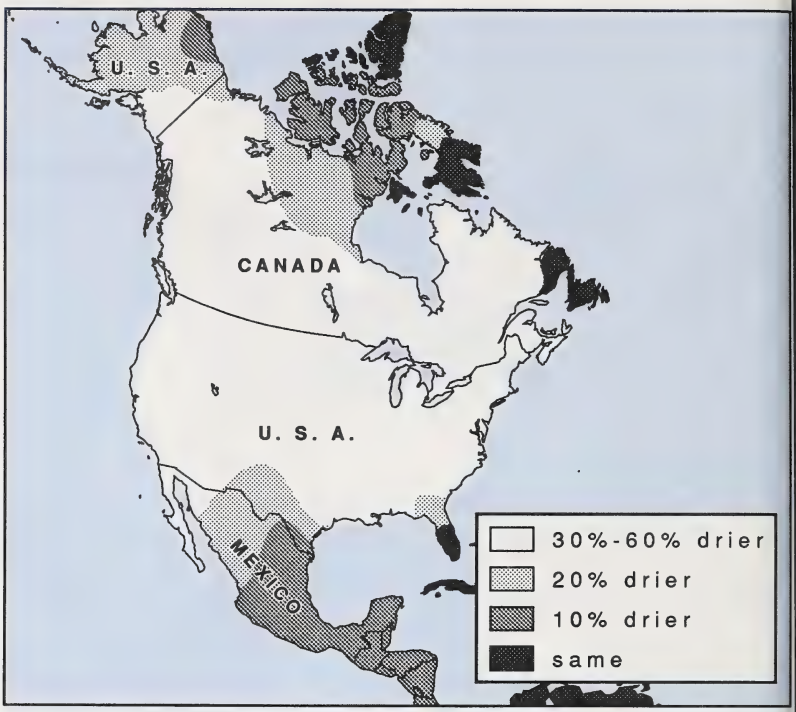


More infrared radiation is being absorbed by the carbon dioxide and other greenhouse gases. Therefore, less heat is escaping from the Earth. This means that the average temperature on the Earth is increasing. The following graph shows the increase in atmospheric carbon dioxide over the last 140 years.



The increase in carbon dioxide levels is an unforeseen consequence of burning fossil fuels. The greenhouse effect is an unforeseen consequence of increasing carbon dioxide levels. What are some possible unforeseen consequences of the greenhouse effect? A temperature increase will mean that the polar ice caps will begin to melt more. This extra water will raise the level of the oceans. Since large parts of the world population live in coastal areas, these people, their farms, and their cities will be flooded permanently. Large areas of some of the most fertile land on Earth will be covered by the ocean. Another consequence will be a change in global climates. Some areas will be drier; other areas will be wetter. Many of the world's best grain growing regions will be drier, making it harder to grow grain. Some areas that get wetter will probably suffer from greater erosion effects.

Soil Moisture and the Greenhouse Effect



8. Use the information given in the map to predict how the greenhouse effect will affect Alberta.

   a. forests:

   _____

   _____

   _____

   _____

   b. farmers:

   _____

   _____

   _____

   _____

9. What are two unforeseen consequences of the burning of fossil fuels?

_____

_____

_____

10. Name two greenhouse gases.

_____

_____

11. Explain how greenhouse gases trap heat in the atmosphere.

_____

_____

_____

_____

_____

_____

12. What technologies do you think are responsible for the increase in atmospheric carbon dioxide?

_____

_____

_____

Check your answers by turning to the Appendix, Section 2: Activity 1.

Activity 2: Major Solutions

WESTFILE INC.

Everyone has heard of "the good old days." There are many ways in which those days were better than today. There are also many ways in which those days were not nearly as good as today.

Technological advances have resulted in higher productivity and better working conditions in farming and industry as well as in corporate and commercial business.

In the past farming was a highly labour-intensive occupation. Productivity was low, and subsequently the standard of living was very low. As technology made advances, farming became more mechanized and efficient. The standard of living for farmers was greatly increased.

What are some of the technologies that have had a major impact on farming? The advances in the technologies related to steel production allowed for the manufacture of new farm machinery. Especially important was the manufacture of the internal combustion engine. Gasoline and diesel engines led to increased productivity. Society as a whole, not just the farmers, benefited from these technological advances since food became more plentiful and less expensive.

People began to move to the towns and cities since farming no longer required as much manpower. This shift in population led to greater industrialization, especially in the cities.

Industrial labourers used to have horrible working conditions, long hours, and very low wages. Technological advancements and societal pressures have increased worker productivity, safety, and wages. There were many technological developments that were responsible for this increased productivity. A safe and reliable power supply was provided with the development of electrical and petrochemical technology. An incredible variety of machines have been created to perform menial, repetitious tasks with precision and great speed. Robots and computer-controlled machinery are now able to perform many intricate tasks that humans could not possibly perform. Machines are also able to do heavy and dangerous work. Workers are now trained to service the machinery as well as to do their work.

People used to die from many diseases, sometimes from the cure as much as the disease. Simple infections could lead to the amputation of a limb. People were plagued with parasites, both internal and external.

Medical technologies have changed dramatically in the recent past. There is a variety of medical technology used for the diagnosis and treatment of health problems. Some of these include lasers, xrays, CAT scans, and radioactive imaging devices. There is a vast number of research and production laboratories which test and produce an incredible variety of drugs and medications that are used by modern society. The cost of modern medicine is very high and not available to all those who need it. Most people in third world countries do not have access to modern medicine, the result being higher death rates and a shorter life span.

1. Describe how the advancements in the sciences and technologies related to these fields have affected your life.

   a. farming:

   b. industry:

   c. medicine:

2. Science is the provider of ideas which then require new technologies to make them a reality. Give one example of a scientific idea which has led to the development of new technologies.

3. Technology sometimes allows for new discoveries and ideas in science. Give one example of how technology has led to new discoveries in science.

4. Discuss the impact of nuclear technology on society.

Check your answers by turning to the Appendix, Section 2: Activity 2.

Activity 3: What Can You Do?

You probably heard about environmental issues such as air pollution, water pollution, oil spills, acid rain, the hole in the ozone layer, deforestation, and garbage disposal. Some people feel that these problems have been caused by various industries and corporations. Others feel that the government is responsible for regulating industry and ensuring that the environment does not become polluted. Still others feel that each individual in society is responsible for the environment. So who's right? What has caused all these problems? The answer to this question is not simple.

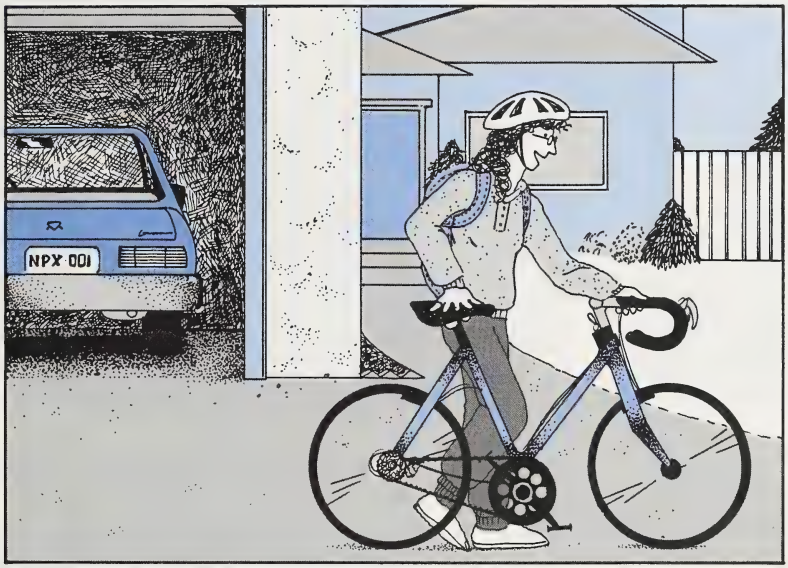
Industry produces products at a low cost because society demands inexpensive products. Society is responsible for electing a government that will carry out the policies that society demands. If jobs and inexpensive products are more important to society than the environment, the government will be reluctant to impose strict environmental standards on the industries.

What can you do as an individual to help clean up and preserve the environment? You can apply political pressure by voting, writing letters to politicians, and by being a member of a lobby group. You can also apply pressure to polluting industries by boycotting their products. The most important thing that you can do, however, is to lessen you own personal impact on the environment.

A More Environmentally Friendly You

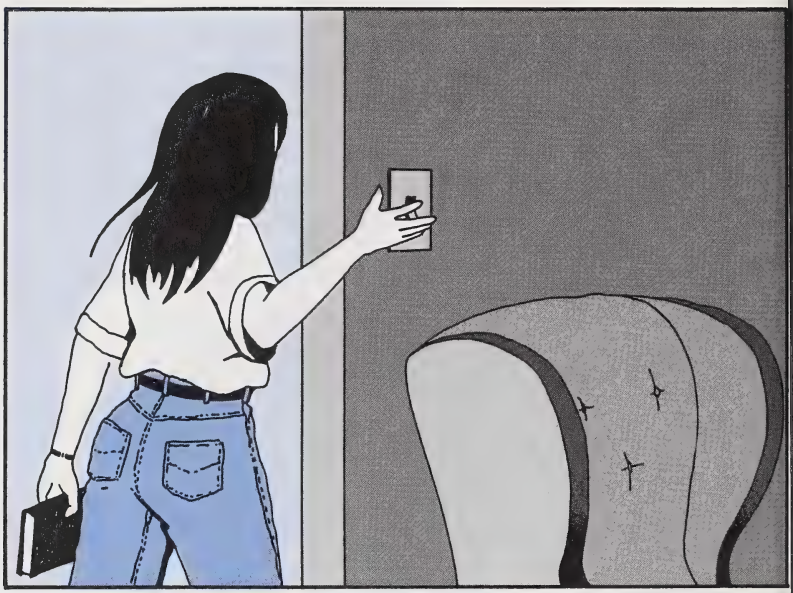
Look at your lifestyle. There are many things that you can do to reduce the amount of products that you use. Each time you reduce your consumption of a product, you reduce the amount of waste that is produced in the making of the product. This approach is most worthwhile if you reduce the amount of product that you personally waste. Here are some examples of simple things you can do to reduce consumption and lessen your impact on the environment.

Walk or ride a bicycle instead of driving.



If you drive (or if someone else drives you) to places that are within walking or bicycling distance, you are wasting precious fuel, polluting the atmosphere, and also losing an opportunity to get some exercise. A vehicle can burn 1 L of fuel to drive two blocks to the store and back. If you walked, you could save 1 L of gasoline. One litre of gasoline may see unimportant, but multiply the effect by 25 million (the approximate number of people in Canada). If, on average, each Canadian walked the two blocks just once a year (instead of driving), 25 million litres of fuel would be saved. With a conservative limit of 10 L/100 km, a vehicle could drive for 250 million kilometres on the amount of fuel saved.

Turn off any lights and appliances when they are not in use.

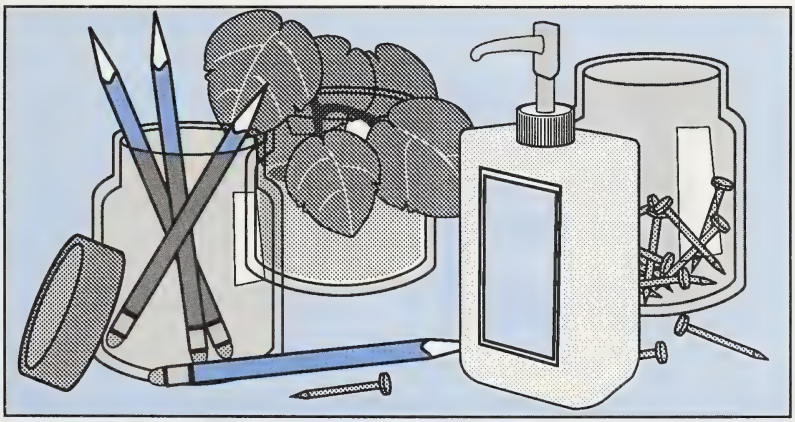


This simple, painless act of conservation will reduce the amount of pollutants released into the atmosphere by the power plants. Convince the rest of your family to follow your example. You will save money on your power bill while helping the environment.

Purchase goods that have a minimum amount of packaging, and buy in bulk to reduce packaging.

Most goods are packaged in elaborate ways to attract the consumer. This packaging consumes valuable resources and energy and will contribute to the growing mountain of garbage once it is thrown out. Buy goods that are packaged only as much as necessary and let the manufacturers know that you will not buy overpackaged goods. When you buy larger, more economical quantities you save money and reduce the amount of waste, especially in packaging. A 25 kg sack of rice is much more environmentally friendly than a 500 g box of "Uncle Don's" quick rice.

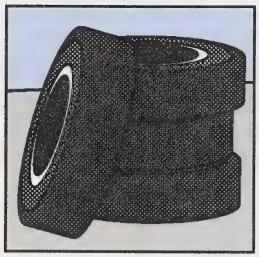
Reuse items whenever possible.



Each time you reuse an item that is normally thrown in the garbage you are reducing the demand for the manufacture of new products to do the same job. Clear jars make excellent containers for storing small items such as nuts and bolts, screws, paper clips, and many other household items. Plastic tubs from margarine and other food products make excellent storage containers for leftovers.

If you cannot reuse a product yourself, there are other people or organizations that can reuse them. Many distributors will take back egg cartons, coat hangers, milk bottles, and many other reusable items. Used clothes, old eyeglasses, used furniture, and other common household items are welcome at many charitable organizations for redistribution to people in need. You not only reduce the amount of garbage that you produce, you also help other individuals lead more comfortable lives.

1. Give two ways to reuse each of the following items.



a. old rubber tires: _____

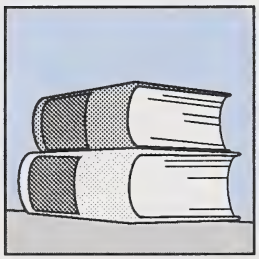
_____

_____

_____

_____

_____



b. books: _____

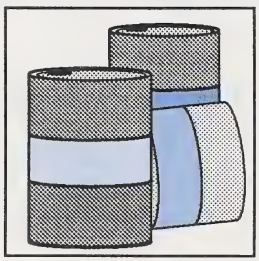
_____

_____

_____

_____

_____



c. steel drums: _____

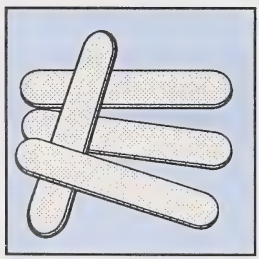
_____

_____

_____

_____

_____



d. Popsicle™ sticks: _____

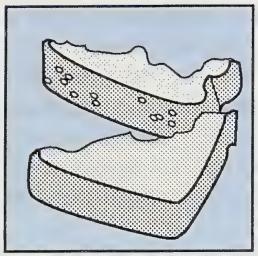
_____

_____

_____

_____

_____



e. bread crusts: _____

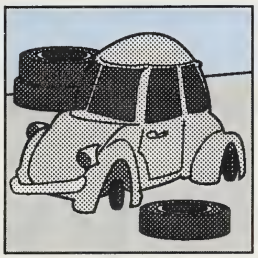
_____

_____

_____

_____

_____



f. old cars: _____

_____

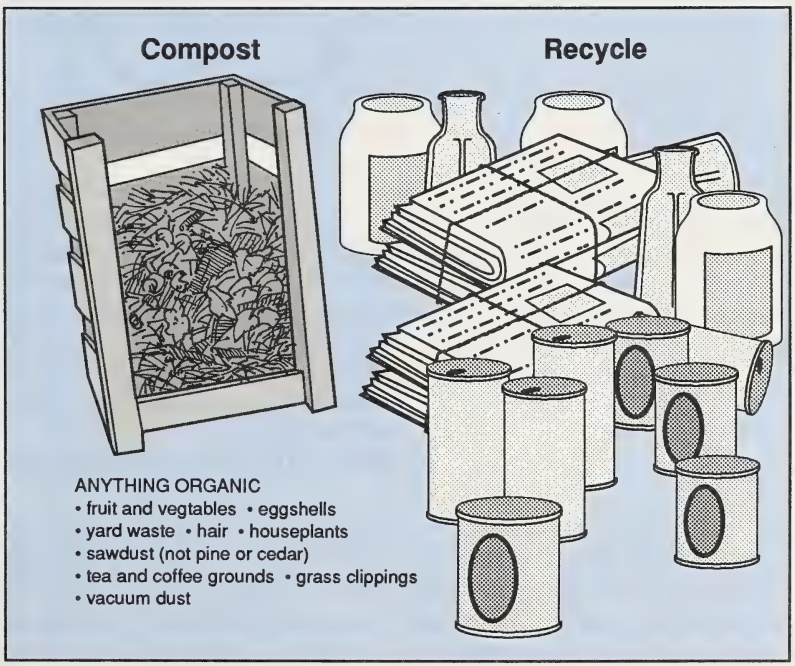
_____

_____

_____

_____

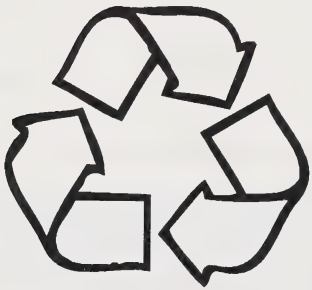
Recycle whenever possible.


Compost
Recycle
ANYTHING ORGANIC
• fruit and vegtables • eggshells
• yard waste • hair • houseplants
• sawdust (not pine or cedar)
• tea and coffee grounds • grass clippings
• vacuum dust

You can recycle most of the biodegradable wastes that are produced in your home. A simple compost pile in your garden will turn many household wastes into fertile soil. The only things that you should not put into a compost pile are nonbiodegradable wastes, hazardous chemicals, and meat or dairy products. Meat and dairy products will attract flies and cause your compost pile to smell. A proper compost pile will have no smell. This is a great way to reduce the amount of garbage you send to a landfill site.

Most types of metal, plastic, glass, and paper are recyclable. You just have to clean and sort the materials and take them to your recycling depots. Some cities even have a home pick-up program, such as the Blue Box program. Used oil and antifreeze can be recycled by taking them to a drop-off center (maybe your local automotive garage).

Buy recycled products or environmentally friendly products.



Recycled Product

Environmentally Friendly Product

If you buy a product that has already been recycled, you are doing at least two important things. First, you are reducing the demand for new products and thus reducing the demand for scarce resources. Secondly, you are promoting the technologies which produce recycled products and this demand will lead to new or better recycling technologies. You should also remember that some products are more environmentally friendly than others. Look for the symbols which identify recycled or environmentally friendly products. You will be doing your environment a big favour.

2. List six things that you can do to reduce your impact on the environment.

_____

_____

_____

_____

_____

_____

3. List three things not mentioned in this activity that you can do to help the environment.

_____

_____

_____

Check your answers by turning to the Appendix, Section 2: Activity 3.

As a member of society you can influence the government's decisions regarding industry and the environment.

Industries produce products. You can phone or write to specific industries to make them aware of your concerns. Telling them that you refuse to buy their products until they control their pollution probably will not bring immediate results, but if enough other people follow your example a change will likely be made. There are a variety of consumer groups which have a much greater influence on the industries because of their large memberships. Belonging to such a group can increase your leverage when asking for a cleaner and greener environment.

Did You Know?

The largest and best known environmental organization, Greenpeace, originated in British Columbia in 1971 as a small group opposed to nuclear testing in the Pacific ocean. It is now an international network with millions of members. One of the main goals of Greenpeace is to draw attention to the violation of ecological principles, such as the testing of atmospheric nuclear weapons.

Government policies on environmental issues are a reflection of the society that supports the government. If you are old enough to vote, it is up to you to vote for the political party that best represents your views. Letters to your MP (member of Parliament, federal government) or MLA (member of the legislative assembly, provincial government) will allow you to express your concerns directly to the government.

The government is responsible for monitoring and policing the amount of wastes that are released into the environment. There are many lobby groups that represent large numbers of people. These groups put pressure on the government and politicians in order to get positive action for the environment. Such environmental groups pressure the government to reduce deforestation, to stop building dams, and to reduce the amount of harmful wastes produced by industry.

Follow-up Activities

Extra Help

Every action has a consequence. Some consequences are predictable, while others are unforeseen and may take several years to have a measurable impact. When you begin to analyse the circumstances which lead to unforeseen consequences, you become aware of the immediate impact of science and technology on the environment. You also become able to evaluate the impact that new science and technology might have on the environment as an unforeseen consequence many years from now.

Society exercises some direction and control over science and technology through the government, individual protests or demands, and by mass demonstration. You can influence government by the way you vote, by writing letters to your MP or MLA, by belonging to a lobby group or an environmental organization, and, most importantly, through your own actions. As a consumer you can become more environmentally friendly by reducing, reusing, recycling, and using environmentally friendly products.

1. What is an unforeseen consequence?

_____

_____

2. Give two examples of unforeseen consequences resulting from the invention of the automobile.

3. Describe one way that the science and technology of medicine has improved your life.

4. List three ways that you can exercise control over science and technology as an individual.

5. How does society as a whole control science and technology?

Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

Everyone produces body wastes. Many human diseases are transmitted through untreated sewage which has polluted water and food sources. There are many ways of treating and disposing of sewage. Some methods use high technology, others use very simple technology.

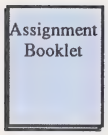
Research two methods that are used to treat and dispose of sewage. In each case discuss the science and technology required, the effect on the environment, and the feasibility for use in your community, in a North American city, and in a third world country.

Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

Most current environmental problems can be related to some type of technology that has been developed by humans to produce the products that society demands. Science and technology are often used without understanding the impact on the environment. Many unforeseen consequences of past technology are now becoming serious environmental problems. Often new technology must be developed to solve these problems.

You have learned how individuals and society can influence new developments in science and technology. Positive influences are those that help ensure that the consequences of science and technology are well researched and that measures are taken to minimize their harmful impacts on the environment. You can personally influence decisions regarding scientific development by writing letters to your MLA, MP, or to the industries themselves. Another way is through membership in lobby and environmental groups. The most important method of all is through personal activities such as reusing, recycling, and reducing.



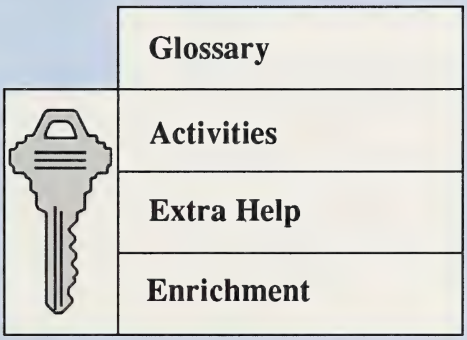
ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 2.

MODULE SUMMARY

In this module you have examined the effects of science, technology, and society on the environment. Some technologies cause serious environmental problems. If society continues to use those technologies because of the demand for their products, then society is responsible for minimizing the environmental damage and for pressing for less damaging technology. You, as a member of society, are responsible for ensuring that science and technology are not misused to the point where the environment is damaged.

Appendix



Glossary

Acid precipitation
- acidified water that falls to the earth as rain, snow, or any other form

CFCs (chlorofluorocarbons)
- a group of chemicals which are destroying the ozone layer
  CFCs are used in refrigerants, propellants, and foam products.

Esters
- a group of chemical compounds that possess a pleasant fragrance

Methylmercury
- a toxic mercury compound which tends to accumulate in living organisms

Greenhouse effect
- the warming of the Earth's surface and atmosphere because of increased levels of gases such as carbon dioxide and methane

Nonbiodegradable
- the inability of a substance to be decomposed by living microorganisms

PCBs (polychlorinated biphenyls)
- a group of man-made compounds
  PCBs are used to get rid of heat in electrical transformers.

Propellant
- the compressed or liquefied gas that is used to force the contents out of a spray can

Synthetic
- man-made; not naturally occurring

Technology
- all the inventions and techniques that people have developed to solve practical problems; science at work

Suggested Answers

Section 1: Activity 1

Investigation: Is Knowledge Enough?

Steps to Follow

1. • You will first have to find some high-quality iron ore. Since you lack any digging tools or analytical equipment, the ore will have to be found on the surface of the land.

   • Once you find some iron ore, you will have to build something in which to smelt the ore. This will be very difficult since you have no tools with which to build the smelter.

   • Once you construct a smelter, you will have to cut enough trees to produce the carbon necessary for smelting. You do not have the tools necessary for cutting down trees but you might be lucky enough to find some coal.

   • Once you gather enough iron ore and carbon, you can smelt some iron.

   • You can then use rocks to pound out a crude and brittle iron knife blade.

   • To turn iron into steel you would first need a blast furnace to remove excess carbon and other impurities from the iron. Then you must add special elements such as chromium, nickel, or tungsten to turn the molten iron into steel.

Conclusions

2. • tree-cutting tools
   • mining tools
   • smelter
   • hammers to pound the iron into a knife shape
   • any other technologies that may be listed

3. People in Europe, Asia, and some parts of Africa had developed the technologies to produce steel. They had also developed the technologies necessary to transport the raw materials, finished products, and labour. This process of development took a long time. People that did not develop the technologies necessary to get out of the Stone Age suddenly found themselves confronted by people with superior technology. Since these Stone Age people could not make these products, they bought them using raw materials as payment.

4. a. The airplane is dusting a crop of some kind, so you would be producing either vegetables, grain, or fruit.

b. The spray is used to control either insects or weeds. There are many problems associated with spraying this way. Many other insects or plants will be killed. The spray may be long-lived and get into the ground water. There are other things to consider. How much harm is done to the environment through the production of the airplane, the fuel and lubricants, and the spray being used?

c. In order for the product to be produced less expensively, somebody has to do their job for less money.

- The farmer might be asked to sell his crop for less money.
- The airplane pilot might be asked to spray the crop for less money.
- The companies that produce the airplane, fuel and lubricants, and chemical spray might be asked to manufacture their products for less money.
- The farmer might be asked not to use any spray, even though the crop might be ruined.

You might also have argued that if everybody involved was to work more efficiently the cost of the product would be reduced.

5. a. Wood products are being produced. This can include lumber, paper, and a variety of processed wood products.

b. The clear-cutting of a forest destroys wildlife habitat and displaces the organisms which were living in the forest. The technology related to the forest industry is polluting and damaging the environment (i.e. the bulldozer, the fuel burned, the pulp mills, the paper mills, and the lumber mills).

c. The main reason for clear-cutting is economics. The consumer demands high-quality wood products but wants them to be inexpensive. Selective cutting is less harmful to the environment but is more expensive. Any attempt to reduce the pollution from pulp, paper, and lumber mills will result in increased costs to the consumer. Labour costs could be reduced to make a less expensive product.

6. Industry has used technology to develop environmentally safe propellants. These are gases which will not harm the ozone layer. Sprays are also available with an aerosol pump. The consumer pushes down on a mechanical pump to create a spray.

7. Instead of using common dry cell batteries you could

- use rechargable batteries
- use an AC adaptor to plug your electronic devise into household current

All these alternatives will reduce the number of dry cell batteries that would be discarded into a landfill site.

8. DDT is a fat-soluble chemical which is stored in the body fat of living organisms. Plant-eating animals, such as cows, eat plant material with small amounts of DDT. The DDT becomes concentrated in the cows and in the cow's milk. Humans drink milk and eat cows and calves. Both of these foods contain DDT which becomes concentrated and passed on in mother's milk.

9. The burning of leaded gasoline releases lead into the air. This lead enters your body when you breathe in polluted air. It becomes concentrated in your body tissues and can cause damage to the brain and nervous system, increase blood pressure, and increase your risk of heart attack.

10. This is hard to do because a VCR does not seem to produce any harmful wastes. But the technologies that produce the VCR, the video tapes, and the power that is needed to run it all produce nonbiodegradable wastes. You could also include the television, transportation, and marketing technologies as contributing to the production of nonbiodegradable wastes. Finally, the VCR itself gets thrown out when it becomes outdated.

11. Society, the individual industries, and the government are responsible for recycling nonbiodegradable wastes.

12. Nature recycles biodegradable wastes.

13. Synthetic chemicals can pose problems for nature and society because they are often

    - nonbiodegradable
    - may be very poisonous or harmful to your health
    - may take a long time to break down
    - may be biologically magnified (they may build up in concentration as they move up through the food chain)
    - may be very difficult to reduce to less harmful chemicals

Section 1: Activity 2

1. The amount of garbage produced will also increase.

2. Hopefully you said that the best way to dispose of garbage is to recycle it. Biodegradable wastes should be used to replenish the nutrients in the soil of farmland. Nonbiodegradable wastes should be recycled.

3. a.
    - landfills
    - farming
    - forestry
    - industrial and urban development
    - recreational use of land

b. • landfills: Lower land areas are filled with garbage and eventually covered with soil.

• farming: Forests, grasslands, and wetlands are replaced by croplands.

• forestry: Forests are often clear-cut and reseeded with a single species of trees.

• industrial and urban development: Land is levelled and paved for roads or covered with buildings.

• recreational use of land: Land is changed to suit the needs of recreation. This can result in changing the types of plant and animal life or restructuring the surface of the land.

4. You could change farming, forestry, industrial, urban, and recreational practices in order to preserve the natural environment.

Section 1: Activity 3

1. a. Some advantages of solar heating are

• reduces pollution by not consuming gas or electricity
• reduces the cost of heating your home (solar energy is free)

b. Some disadvantages of solar heating are

• high initial cost of equipment and insulation
• solar energy is not totally dependable (during the winter, on cloudy days, or at night)
• in Alberta solar energy is at a low when you most need it (in the winter)

2. Efficiency and high cost of equipment are the main reasons. Solar and wind energy are not dependable sources. Geothermal energy requires high input costs to drill wells and set up generating plants. Good locations for generators are often far away from the places where the energy is needed.

3. a. Third world countries often contain human populations which have exceeded the limits of the environment. In these cases, a reduced population would result in fewer famines and a healthier environment. More time and money could be spent helping people achieve a higher standard of living, instead of just helping people to stay alive.

b. You might agree to the same kinds of birth control measures in order to reduce population growth. You might not agree because of your beliefs or because you feel that no outside force should influence the size of your family. Remember that people in third world countries are entitled to the same views and feelings as you.

4. They could use better farm equipment, chemicals, irrigation technology, and development of better seedand animal strains.

Section 1: Follow-up Activities

Extra Help

1. This is an interesting question. All processes, including life processes, produce wastes because the final product is different than the materials from which it was produced. (If not, then the product would already be there). Energy is usually used to produce the product and heat is often given off as waste. All of the materials which are not present in the product are removed as waste. Biological processes produce wastes which are recycled in the natural environment. Industrial processes often produce wastes which are nonbiodegradable.

2. The nonbiodegradable wastes must be properly destroyed or disposed of in landfills or hazardous waste sites.

3. While natural gas is one of the cleanest burning fossil fuels, the production of carbon dioxide from the combustion of natural gas increases the carbon dioxide level in the atmosphere. Since carbon dioxide is a greenhouse gas, it contributes to global warming.

4. When a chemical is fat soluble it tends to be stored in the bodies of the animals that eat it. This chemical is then passed on through the food chain, where it becomes more concentrated in higher level consumers.

5. People today are more aware of environmental issues and problems. Recycling is one way to reduce the use of materials such as aluminum, steel, and glass. You can also conserve energy by recycling, since it takes much less energy to make steel and aluminum cans from recycled products. Recycling is also a good way to reduce the amount of garbage going to a landfill.

6. One unforeseen consequence of this suggested policy is the infant death of many females. Some cultures still believe that male children will take care of their parents when the parents get old; so it is very important to have a boy when only one child is allowed. This policy sometimes leads to the aborting of female babies or making sure that female babies die soon after birth. The purpose of this policy is to achieve zero population growth and to lessen environmental impact.

Enrichment

1. The benefits are reduced chemical use, reduced insect populations, better crop yields, and, of course, turkey as food. Wastes from the turkey might also function as fertilizer.

2. There are some important points to consider:

    - These turkeys were used in a garden which was fenced properly. Farmers cannot just set turkeys free in their grain fields, so that while the small garden might be insect free, the rest of the farm would still need massive amounts of insecticides to control the grasshoppers.

    - Turkeys are labour intensive. They have to be fed, watered, sheltered, protected from predators, and cleaned up after. Few people are willing to spend the large amount of time that is needed to look after a few turkeys.

    - Just because you have fifteen turkeys does not mean that fifteen turkeys will live to maturity. Disease, predation, and parasites can reduce the number of turkeys.

3. People need a clean, healthy environment. If the wants of a society result in technology that pollutes the environment, then this contradicts the need for an unpolluted environment. The basic need to live far outweighs any wants. Society will immediately press for technology that can satisfy its wants without polluting the environment. Sometimes technology causes pollution in distant places and does not directly affect the society that demands the products. It then becomes very difficult to make the necessary changes. A good example is the acid rain problem in Canada. Much of the pollution that causes acid rain is produced in the United States. It is very difficult to make the society in the U.S. clean up that pollution because they are not suffering the consequences. Technology and pollution do not obey geographical borders.

Section 2: Activity 1

1. No one realized that mercury compounds would be found in their seafood and poison the people who ate the seafood. Only after people were poisoned did scientists discover that the mercury compounds accumulated in the bodies of organisms and then were magnified in the food chain. It was also unforeseen that these compounds could exist in the environment for such long periods of time and spread through large bodies of water.

2. Two of the most important consequences were

    - many bird populations were drastically reduced because seed-eating birds were poisoned, and predatory birds in higher levels of the food pyramid were also affected

    - some people fed treated seed to their farm animals, which then poisoned the animals, the products made from them, and the people who ate the animals and products

3. This answer can vary from tens to hundreds of years. It depends on the severity of the pollution and the type of area. In some areas the pollution can be covered with sediments, in others the pollution may continue to leach into the soil or water for very long periods of time.

4. There are many lakes and rivers in Canada and Alberta which are polluted with mercury. In some cases the mercury levels are so high that people are told not to eat the fish from these areas.

5. Acid precipitation is any form of precipitation, like rain, snow, or sleet, which has been acidified by dissolved sulfur or nitrogen oxides.

6. Most of the precipitation in the populated regions of the world is in the form of rain rather than snow.

7. Acid precipitation, which often falls far from the industrialized area which causes it, is one unforeseen consequence of highly industrialized areas.

8. a. forests: If Alberta becomes 30-60 percent drier, large forested areas will be replaced by grasses. Northern Alberta will look more like southern Alberta does today and southern Alberta may become a desert.

   b. farmers: There may no longer be enough rain to grow traditional grain crops. Farmers will have to either irrigate or plant crops which can grow to maturity on less water.

9. Increased carbon dioxide levels in the atmosphere and the greenhouse effect are two unforeseen consequences of the burning of fossil fuels.

10. Carbon dioxide and methane are two greenhouse gases.

11. Greenhouse gases allow the radiation from the sun to pass through the atmosphere. When the radiation is absorbed by the Earth, it is reradiated as heat. The greenhouse gases absorb this heat (infrared radiation) and warm the atmosphere.

12. Any technology which produces carbon dioxide is responsible for atmospheric carbon dioxide. Some of these are automobiles, power plants, burning fossil fuels, and deforestation involving the burning of trees.

Section 2: Activity 2

1. a. farming: There are many technologies that have improved production, such as tractors, combines, and specialized machinery. Research has produced new and better strains of crops. All of this science and technology in farming makes your life more pleasant by producing better, less expensive, and more nutritious food.

   b. industry: Virtually all industries use modern science and technology to produce modern products. Almost any product you use makes your life more pleasant, otherwise you would not use it.

   c. medicine: Virtually all medical products, such as drugs and equipment, are the result of modern science and technology. Your life is made more pleasant because most ailments and diseases can be diagnosed and treated.

2. Almost every new technology is a result of pure science. An example is nuclear technology. Science formulated the ideas and directed the type of technology required. By harnessing nuclear reactions, scientists were able to develop technologies such as nuclear power plants and atomic bombs.

3. Your answers may vary. One piece of technology that has led to new discoveries in science is the microscope. A whole world of tiny organisms was opened to science when the microscope was developed. Bacteria and other microorganisms became visible along with the cells which make up your own body.

4. Nuclear technology has been a mixed blessing. The technology produces weapons with devastating effects and nuclear power plants which produce power. Nuclear power plants also produce radioactive wastes which are very difficult to handle and store. Nuclear technology is very dangerous; a single nuclear power plant accident, such as the one in Chernobyl, can make vast areas of land impossible to live in and pollute even larger areas of land. Nuclear accidents also cause widespread death, disease, and destruction.

Section 2: Activity 3

1. a. old rubber tires: These can be used in playgrounds, for tire bridges or swings, as planters for flowers, as bumpers for boats and wharfs, and tires can be ground up and mixed with other substances for paving roads.

   b. books: These can be traded, sold at garage sales and second hand stores, and given to hospitals or other charitable organizations.

   c. steel drums: These can be used as rain barrels, for composting, and they have been made into a musical instrument, the steel drum.

   d. Popsicle™ sticks: These can be used for crafts, as handles for candied apples, and as wooden coffee stir sticks.

   e. bread crusts: These should be air-dried and then used for breadcrumbs, croutons, stuffing, bread pudding, and bird feed.

   f. old cars: These can be used in demolition derbys, as parts for cars that are still running, and as parts for various projects. For example, an old steering wheel could be used on a go-cart or soapbox racer.

2. There are many things that could be done to reduce your impact on the environment some examples are

   - drive your vehicle less
   - reduce energy consumption by turning off lights and appliances when they are not in use
   - buy items with less packaging and buy in bulk
   - reuse everything you can, let others reuse those things that you cannot reuse
   - recycle whenever possible
   - buy recycled or environmentally friendly products

3. To help the environment you could

   - Reduce your water consumption. The less water you use, the less water must be processed, and the less sewage that must be returned to the environment.

   - Never throw or dump any hazardous materials such as oil, antifreeze, or any household chemicals down the drain.

   - Always send hazardous materials, such as paint, pesticides, and medicines, to a proper place for disposal; never take them to the dump or landfill site.

4. In your letter you should include concerns specific to both your area and to more general areas such as forests, farms, lakes, and oceans.

Section 2: Follow-up Activities

Extra Help

1. An unforeseen consequence is one that was not predicted or seen as being able to occur. Consequences are the result of an action. When you are cutting a piece of wood with a saw, one consequence is that the piece of wood will be cut. There are many other consequences to this action. The experienced carpenter knows enough to protect his eyes, to watch his hands, and to wear hearing protection and proper clothing. The inexperienced person may suffer some unforeseen consequences such as serious injuries.

2. Air pollution, noise pollution, acid rain, the greenhouse effect, personal injury, and death are only a few unforeseen consequences of the automobile.

3. There are no incorrect answers because there are so many possible ways that the science and technology of medicine helps an individual. Some possible answers might be as follows:

   - glasses or contact lenses make it possible to see clearly
   - medicines which control conditions such as diabetes and high blood pressure

4. You can exercise control over science and technology in the following ways:

   - Have your elected government control the science and technology by law. You can influence your government by writing your MP or MLA.
   - Buy only the products of science and technology that you can feel are good. Do not buy products that are produced by science and technology which are harmful.
   - Belong to an organization which can carry out your personal agenda. A larger group will exert far more pressure on the government and science and technology than an individual will.

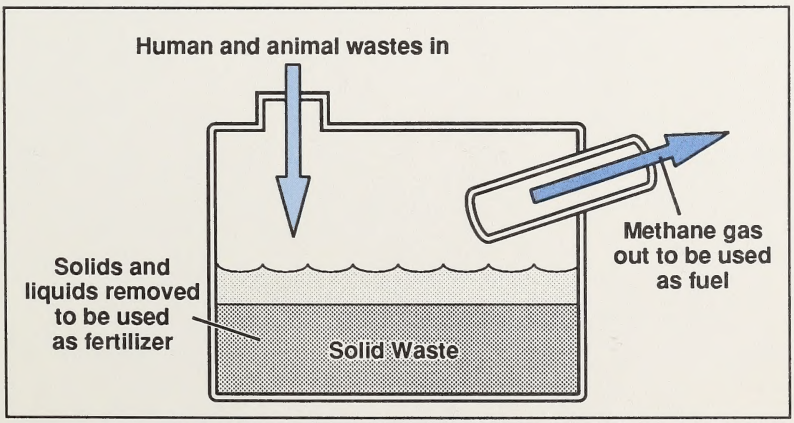
5. Society exerts some control over science and technology by demanding (and paying for) certain products and processes. Society demanded a solution to smallpox; science and technology delivered by developed a vaccine which eliminated the disease. All countries and peoples had to cooperate to eliminate smallpox. There are many other examples of society controlling science and technology.

Enrichment

The most common method for treating sewage is found in large North American cities. The wastes are collected, left to settle so that large particles fall to the bottom, and then skimmed to remove oils and other floating substances. The wastes may be further treated in a variety of ways involving aeration and chemicals. Less technologically advanced methods are now being researched. Some of these skim oils from the surface and run the remainder into large lagoons where natural biodegration breaks down the wastes. This process requires large areas of land since the biodegradation requires long periods of time.

Many developing countries, China in particular, use animal and human wastes to produce methane for fuel. Another byproduct of human and animal waste is fertilizer which can be used to grow better crops. This simple method is very friendly to the environment, requires little technology, and provides both fuel and fertilizer for people.

Bio-gas Production


Human and animal wastes in
Methane gas out to be used as fuel
Solids and liquids removed to be used as fertilizer
Solid Waste

3 3286 11541553

Science 14

9SC14P28

L.R.D.C. SECOND EDITION
Producer 1991